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DEDICATION OF THURSTON MEMORIAL

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

New York, February 8, 1910

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

DEDICATION OF MEMORIAL TABLET

TO

ROBERT HENRY THURSTON

TUESDAY EVENING, FEBRUARY 8, 1910
IN THE ENGINEERING SOCIETIES BUILDING
29 WEST 39th STREET, NEW YORK

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DEDICATION OF MEMORIAL TABLET TO ROBERT HENRY THURSTON

A bronze memorial tablet to Dr. Robert Henry Thurston, first president of The American Society of Mechanical Engineers, was dedicated at the New York monthly meeting, Tuesday evening, February 8, 1910, in the auditorium of the Engineering Societies Building, in the presence of many associates and former students of Dr. Thurston as well as of members of the Society. This bas-relief, which is the work of Herman A. MacNeil, a former student and personal friend of Dr. Thurston, and is a replica of the memorial tablet presented to Sibley College, Cornell University, by alumni and students, was placed in the rooms of the Society through the generosity of members, as an expression of their devotion to Dr. Thurston. The contributions were received by a committee consisting of John Fritz, S. W. Baldwin, Prof. R. C. Carpenter, Walter C. Kerr, E. A. Uehling, Wm. Hewitt and Gus. C. Henning; and the details connected with the acquiring of the tablet, its installation and the arrangement of the dedicatory exercises, were in the hands of Dr. Alex. C. Humphreys, *Chairman*, Chas. Wallace Hunt, Fred J. Miller, Prof. R. C. Carpenter and J. W. Lieb, Jr.

The program of the evening was designed to cover the various phases of Dr. Thurston's brilliant career, treated in each case by a speaker of wide reputation who had known Dr. Thurston intimately during this period of his life. It therefore very appropriately included an address on Dr. Thurston's relationship with the Society, by Prof. John E. Sweet, President of the Society from 1883–1884 and active with Dr. Thurston in its organization; a communication on Dr. Thurston's career as a naval engineer, from Rear-Admiral Benjamin Franklin Isherwood, U.S.N., Retired, Honorary Member of the Society, which was read by Prof. F. R. Hutton, Honorary Secretary; an address on Dr. Thurston at the Naval Academy at Annapolis, by Rear-Admiral George W. Melville, U.S.N., Retired, Honorary Member and Past-President, Am.Soc.M.E.; on Dr. Thurston as professor at Stevens Institute of Technology, by Col. E. A. Stevens, trustee and treasurer of Stevens Institute and son of its founder; on Dr. Thurston's literary and research work, by William Kent, one of the organizers of the Society and a close friend and co-worker with Dr. Thurston; and on Dr. Thurston as director of Sibley College, Cornell University, by Walter C. Kerr, a trustee of Cornell. The Chairman of the Thurston Memorial Committee, Dr. Alex. C. Humphreys, president of Stevens Institute of Technology, presided over the meeting.

After the addresses of the evening, members and guests proceeded to the eleventh floor where the tablet was unveiled and presented by Dr. Humphreys, on behalf of the committee, to the Society, for whom it was accepted by Col. E. D. Meier, Vice-President. Col. Meier declared this to be the first bronze statue of an eminent engineer erected in the United States in a great building devoted entirely to engineering and said that an excellent choice had been made in Dr. Thurston as a representative of his profession. Dr. Humphreys also presented to the audience Herman A. MacNeil, the artist, who made the concluding remarks of the evening.

It was a matter of regret that Mrs. Thurston found it impossible to be present at the meeting. A letter was read by the Chairman, expressing her appreciation of the honor rendered to Dr. Thurston. Messages were also received from President Westinghouse, who was prevented by urgent business from attending, and from Chief Engineer Chas. H. Manning, U. S. N., and Lieut.-Commander Robert Crawford, U. S. N., associated with Dr. Thurston in the Naval Academy at Annapolis.

The addresses of the evening follow.

INTRODUCTORY REMARKS

By Dr. Alex. C. Humphreys, Chairman

Member of the Society; President of Stevens Institute of Technology

While recognizing that it is not the function of a presiding officer to forestall the speakers to be introduced, I cannot refrain from saying a few words about my friend and preceptor, Robert H. Thurston. Others will tell you of his widely varied activities, his tremendous capacity for work, which was nevertheless overtaxed, his quickness of brain and speech, his powers of exact determination and expression, his capacity for organization and execution, his eminence as an engineer and educator. I prefer to think of him as the large-hearted, gentle, lovable, helpful man, the man of vision, the optimist.

While a student at Stevens, I was not fortunate enough to have Dr. Thurston's guidance during my junior year, for then, in 1879, he had not yet recovered from the almost fatal nervous breakdown, which resulted from his strenuous life in many lines of activity. But I came to know him well during my senior year, and had many occasions to be deeply grateful to him for his assistance and encouragement, which I then greatly needed. I never saw him other than cheerfully responsive to a request for help, and I was never allowed to feel that I was intruding when I went to him for counsel. While demanding respect and obedience from those under him, his attitude towards them was characterized by a sympathetic desire to be helpful.

Wm. Kent, one of the speakers of the evening, in his masterly biographical notice of Dr. Thurston in the Sibley College Journal, in writing of the vast amount of work performed at a certain time by Dr. Thurston, says: "And during all this time, I never saw him excited or ruffled over his work." We busy, overcrowded men, know this to be high praise indeed.

I met Thurston too seldom after I graduated from Stevens, but when we did meet, I was made to feel that he was really interested in my career, and that he rejoiced and sympathized with me as circumstances suggested. I like to remember that he came down from Cornell at the time of my inauguration as president of Stevens Institute, and that it was through him that Cornell University and Sibley College conveyed their good wishes to Stevens Institute and to me at that time. Later in that year he quietly passed away to his well-earned rest.

Thurston was a man of vision. Time and again this is shown in his writings, and especially in view of later developments. And this, notwithstanding that his declared results were sometimes afterwards amended, as must be the case with those who are courageous enough to act the part of pioneers.

We are, apparently, now only beginning to appreciate in this country the practical and commercial value, to say nothing of higher things, of technical and technological education. And even now, those who do have the appreciation are unable to move and guide those who have the power to provide the means for the necessary improvement in our educational methods. Years ago, Thurston wrote: "Germany has substituted for the now obsolete apprenticeship system, the systematic, scientific methods of preparing her youth for the future of their lives in all departments of instruction and industry."

He was a student of political economy and education and pointed out the evils which would come to us unless certain lines of reform were followed, the evils which are now upon us and have to be met by patience, wisdom, firmness and common sense.

It was said of his father: "Throughout his life, his benevolence, his uniform kindness to employes and to all with whom he came in contact, and his strong attachment to his friends, made him as universally beloved as he was widely known."

The son was strong in faith though he did not carry his religion in his sleeve. He gave voice to his faith in a certain article which received wide attention, entitled, The Scientific Basis of Belief. It seems to me that the summation of his creed is found in a verse which he included in this article:

Strong Son of God, immortal love,
Whom we, that have not seen Thy face,
By faith, and faith alone, embrace,
Believing where we cannot prove.

Notwithstanding his great and varied accomplishments, it is as the holder of this faith, and as the worthy son of this worthy father, that I love to think of Robert H. Thurston.

DR. THURSTON'S CONNECTION WITH THE SOCIETY

By John E. Sweet

Honorary Member and Past-President, Am.Soc.M.E.

We meet tonight to do honor to the first president of The American Society of Mechanical Engineers, elected now nearly thirty years ago. I have been asked to tell the simple story of his connection with the Society. It is fitting that we whose fading memories can give only shadowy reviews of past events do the best we can to record the facts as we recall them.

To begin at the beginning we must hark back to the fall of 1879, when the American Machinist was published in a small office at 96 Fulton St., New York. The journal had been in existence but a few years. It had received contributions from a goodly number of contributors engaged in various branches of mechanical industries and from a wide section of the country. But very few of these contributors were known to the publishers, and fewer still to one another, and the notion came to my mind to get as many of them together as we well could, and give the publishers a surprise party; with a faint notion that it might lead to an organization. I conveyed the notion to one of the contributors, and he at once gave it away to the editor, with the suggestion that some sort of a mechanical association be formed. The suggestion took root in the minds of the publishers, and Mr. Bailey, the editor, came to Syracuse to see me about it; or, in fact, to inveigle me into writing the invitations.

Among those invited were Alexander L. Holley and Prof. Robt. H. Thurston of Stevens Institute, then in a sanitarium in Dansville, N. Y., both of whom entered heartily into the scheme. Before the meeting, which was held on February 16, 1880, Mr. Bailey and I had an interview with Mr. Holley; each was to draw up some form of program for the meeting, and we were to meet the next day to compare notes. As such things usually turn out, Mr. Holley had drawn up a set of rules which were so complete that we could readily endorse them. At the meeting in the afternoon there were something like thirty present, with letters of endorsement from fifteen or twenty others. Mr. Holley acted as chairman, and I well remember the point he made in his opening address, that it had come to that state of affairs that both civil and mining engineering were largely mechanical. A good deal of time was spent in discussion of the rules, which ended in the adoption of those Mr. Holley had prepared; and time was also wasted in settling on a name, until Mr. Copeland said, "Call it 'The Society of Mechanical Engineers." This seemed to settle it, except that in the shuffle the word "American" got incorporated, to the regret of possibly no one but myself.

Mr. Copeland, Charles T. Porter, Mr. Holley, E. D. Leavitt, Jr., and myself were chosen as a nominating committee. The officers nominated were elected at the meeting held April 7, 1880, at the Stevens Institute, over which Henry R. Worthington presided.

At the time of what is now known as the first annual meeting, held in New York, November 4 and 5, 1880, Professor Thurston had regained his health, and was able to preside and to deliver an able address. Professor Thurston was elected president for the second time, and these two were the critical years in the Society's history. We then held three meetings a year, and while Holley and Worthington lived, they formed with Professor Thurston a three-point support that did not rock; but they both died while Thurston was President, and left him to carry the burden. One incident that occurred during this time I shall always remember. Going out from one of the meetings Mr. Worthington, greatly elated over the way things were moving, said to me, "Professor, the thing is going to go." I doubt if any of us had the idea that the Society would reach a membership of 300, while today it takes more than another right-hand cipher added to our figures to record our membership.

Professor, later Dr. Thurston, not only while president, but for a long time later, was more instrumental in helping up the Society than any other man. It is not necessary to enumerate his contributions to the Transactions. He never showed evidence of elation at success or chagrin at defeat. His work enriches every volume of the Transactions, from the first volume down to the time of his death. And every member of the Society needs to open the door of his memory and let the history of its work shine in and enliven his spirit of respect and adoration for the boy, the student and the scholar, the thinker and the worker, the teacher and the guide, the honored member and revered first president of The American Society of Mechanical Engineers, and the man—Dr. Robert Henry Thurston.

DR. THURSTON'S CAREER AS A NAVAL ENGINEER

By Rear-Admiral Benjamin F. Isherwood, Engineer-in-Chief, U. S. N., Retired

Honorary Member, Am. Soc. M. E.

Professor Thurston, in whose honor these commemoration exercises are held, was in all respects an exceptional person, with endowments not only of a very rare but of a very high order. He was a typical representative of the American engineer of the present day; combining a thorough and extensive practical knowledge of his profession with a scientific culture scarcely found in the exclusively theoretical scientist; and he had, in addition, the ability to make these qualifications available to the world by means of an excellent literary education improved by a carefully discriminating practice as a writer, an orator, a mathematician, and an original investigator in the broad field of his profession. The first-class engineer of the present day must also be a first-class scientist as well as a first-class mechanician, besides possessing a mind well stored with the information collected by others of his profession whose aims and achievements are similar to his own.

With these mental powers was associated, in the case of Professor Thurston, so charming a personality that he not only never had a foe, but all who knew him were his friends. His knowledge and his services were at the command of all who sought them, and were rendered in a manner that made the recipient believe that instead of receiving a favor, he was conferring one. Professor Thurston was the author of several books on engineering subjects, which were classics in their day. He was also a prolific investigator of difficult phenomena in engineering, and his numerous reports have much enriched its literature and enlightened its obscurities. He wrote with perspicuity, elegance and ease; and he was a ready and fluent orator on all the scientific topics of the day.

His death was a great loss to the world, and particularly to his own profession of engineering, for his exceptionally valuable life was devoted to the improvement of the world in the only way it could, in his opinion, be improved, namely, by the cultivation of physical science. Great intellectual attainment meant with him, great everything else.

Those who knew Professor Thurston best valued him the highest. My personal acquaintance with him was long and intimate, and it was intensified by our professional interest in the same subjects, notwithstanding the great difference of our ages and temperaments; and none who knew him as well as I did will consider this weak portraiture of him as overcolored. His death at Cornell saddened all who knew him well enough to appreciate his gentle qualities, as well as his lofty aspirations. He was most happily constituted; he lived his life in the sunshine of an entirely normal existence, and by dying in the full flush of manhood and in the consciousness of great achievement, he was saved from decline, and enabled to pay to glory the debt he owed to nature.

DR. THURSTON AT THE NAVAL ACADEMY AT ANNAPOLIS

By Rear-Admiral George W. Melville, U.S.N., Retired

Honorary Member and Past-President, Am.Soc.M.E.

My function is to pay the tribute of the navy to one who was for a time a naval officer and who during his career as such bore himself in a way worthy of its best traditions, leaving a record, the memory of which is still distinct with those of us who were his contemporaries, although it has long since been overshadowed by the greater reputation of his more mature life.

When the engineer came into the navy, he received scant recognition, although we were very fortunate indeed in having as our first representative that grand old man, Charles H. Haswell, who was to drift along in accordance with old established methods, or if he had not been a tremendous worker, his great ability would have failed to give to Stevens the foremost standing which it has held from the very start.

Dr. Thurston had, in a degree rarely found among men devoted to education, a strong touch of the commercial instinct, and it was doubtless this which led him, from the beginning, to direct the work of his students in their experiments along lines of an immediately practical interest to engineers and others. For example, I remember a set of experiments to determine the economy of gas engines at a time when they were just coming into use. This was only one of a great many instances. The hard-headed, practical manufacturers could not fail to realize that a school where the energies were directed in such a practical way must turn out men who would make good in practical life. I need hardly show that this judgment has been verified by recalling the positions now held by many of these graduates, in offices of the very highest importance in the lines of manufacturing and transportation.

So great was the reputation made by Dr. Thurston at Stevens, that he was generally looked upon as the greatest teacher of mechanical engineering in the country; and I happen to have information with respect to the circumstances under which he went to Cornell which shows that when they were looking for a man of the highest accomplishments to take charge of Sibley College, they at first did not consider Dr. Thurston, for the reason that they did not believe any inducement could take him away from Stevens. When the Trustees of Cornell came to the conclusion that they wanted the best man available, and that they were willing to pay whatever was necessary to secure his services, they eventually opened negotiations with Dr. Thurston, which led to his finally going there.

Of his splendid work at Cornell others will speak, and I need only say that it is a marvelous tribute to his ability and reputation that he should have been able to increase the attendance at Sibley College from about one hundred students to over one thousand.

His educational work was so engrossing that it naturally left him little time for keeping up his association with the Navy, although we who remained in the service always felt that in him we had a sincere friend on whom we could depend for such help, whenever needed, as it was in his power to give. Before we finally attained the full recognition of the paramount importance of engineering in the Navy, which, as you know, is now the function of the entire line of the Navy, we had many an up-hill fight, and on several occasions Dr. Thurston materially assisted us by articles in the magazines and by personal appeal. In this connection it is interesting to note that Bennett's History of the Steam Navy, in speaking of an order of the Navy Department in 1870, which was considered very unfair to the engineer corps, mentions that, in consequence of this order, a number of the brightest men in the corps resigned, among them Dr. Thurston. It has been my observation that the participants in an up-hill fight are drawn more closely together than those whose association is always on the winning side. It was doubtless Dr. Thurston's keen recollection of the lack of recognition which he had received while an engineer in the Navy, that made him so willing to help those who were still in the service in their efforts for a proper recognition and consideration of engineering and its exponents.

It has been my desire as a naval engineer and one whose whole life has been spent in the naval service, to voice, in behalf of myself and my colleagues who were and are engineers in the Navy, our admiration for the friend who, during his own short naval career, did so much to add to the reputation of the engineer corps, and by his prominence as an engineer all through his life reflected the highest credit upon naval engineering.

DR. THURSTON AT STEVENS INSTITUTE OF TECHNOLOGY

By Col. E. A. Stevens

Member of the Society; Trustee and Treasurer of Stevens Institute

Thurston's work at Stevens can be divided into two parts: on the one hand his general work as an engineer, including his well known contributions to the literature of engineering and the researches on which they rested; and on the other his share in the development of the work of the Institute and the influence of his personality on his fellow instructors and the undergraduates.

As to the first part I can say but little in the time assigned. The history of mechanical engineering in the United States will always bear witness to his ability, to his untiring energy and to the liberality with which he freely gave to his beloved profession all that his ripe experience and trained observation could give.

Whatever may have been the value of his other work while at

Stevens, none of it surpasses, or I may say equals in importance, his share in the development of the system of instruction and the influence of his personality and of his standard of professional ethics on those with whom he was there thrown into contact.

Forty years ago the American mechanical engineer was mainly the product of the shop and the engine room, with such self-teaching as could be gathered in the leisure hours of a busy life of hard work. Most engineers of that day would admit that draughting and mathematics could be taught in schools, but claimed that such training would produce draughtsmen and mathematicians, not engineers, men who would be of less value in practical work than the lad of the same age who had spent his time in the shop; that the school-bred man would need several years of hard work to knock the school-taught nonsense out of his head, always granting that he had not been irretrievably ruined by his scholastic training.

Such was the general, even if not the unanimous mind of the profession when Henry Morton gathered around himself six men, who with him were to form the faculty of the first American school wholly devoted to the teaching of mechanical engineering. Scientist and scholar as he was, Morton appreciated the gravity and importance of the task set him and selected his fellow members of the faculty with a care and judgment amply justified in the result. Of these men, eminent as they were, Thurston was the one on whom devolved the practical teaching of engineering. The others must have aided, and unquestionably did aid, in giving the training as a whole a practical direction, but it was to Thurston more than to any one other of Morton's first faculty that the prominence of the practical curriculum at Stevens must have been due, and on him therefore it is but fair to bestow a generous share of the acknowledgment due these men. It would be as invidious as it would be useless to apportion to each the share due to his individual efforts.

While Thurston's personality impressed itself on all who met him, whether at Stevens or elsewhere, the lasting result of this impression on the men who there studied under and with him forms a part of the history of Stevens. The material that came to the "Old Stone Mill" was much the same in the early days as since. The early graduates at once took a standing in American engineering work that soon settled once and for all any debate as to the value of a technical training. They carried also with them into the world what was as necessary for the progress of engineering as technical skill or practical knowledge. They had imbibed together with their calculus and thermodynamics that moral and ethical view of their profession without which an engineer's skill and learning is of little value to his country, a thing not absorbed from text books or taught by platitudes, however often reiterated from the lecture platform.

Boys and young men quick to detect cant are equally quick to recognize and value square-dealing and to love and follow and model themselves after the straightforward man. Of all of that first faculty there was no one to whom the undergraduates could and did more confidently look for a square deal than to Thurston. That straight clear gaze, right into your eye, gave at once a confidence in the man and in his methods that experience did not belie.

Single instances prove few cases and a life such as Thurston's is not to be judged by citing examples and incidents. The true measure of his great work and usefulness is the standard set by the great Master, "by their fruits ye shall know them." By no other standard would Thurston have asked to be judged and the fruits of his work at Stevens are proven not by the accomplishment of specially gifted men who studied under him but by the general standing of the Stevens men of this day.

DR. THURSTON IN LITERATURE AND IN RESEARCH

By Wm. Kent

Member of the Society

My acquaintance with Dr. Thurston began near the end of the year 1874, when I called upon him to make arrangements for entering the junior class in the Stevens Institute of Technology. He was then thirty-five years of age. He was at this time professor of mechanical engineering, meeting his classes two hours a day for, I think, five days in the week; he was editing the four volumes of reports of the United States Commission to the Vienna Exhibition of 1873, one of the volumes being written by himself; he had shortly before written a report of the United States Commission for investigating the causes of steam-boiler explosions; he was planning the researches to be made by the United States Board to test iron, steel and other metals, of which he was secretary and the most active member. Besides all this he was writing papers for the American Society of Civil Engineers and for the Journal of the Franklin Institute, concerning the results of his researches. In 1871 he had conducted a series of boiler tests on several different makes of water-tube boilers at the American Institute fair in New York. In 1873 he had organized a mechanical engineering laboratory for the purpose of making engineering researches, the first of the kind to be established in the United States. At about the same time he invented his well-known autographic testing machine for testing materials by torsion, and later he invented a machine for testing lubricants, in which some of the principles of the torsion machine were embodied.

In June 1875, Dr. Thurston called me into his office and told me he wanted me to undertake a research into the strength and other properties of the alloys of copper. I said to him, "I don't know anything about alloys." "That is a good qualification," said he, "you won't have anything to unlearn." He told me how to make a research into the literature of the subject, and how to find indexes to such literature. He had me write him a report of all I could find that was then known about the alloys of copper and tin and copper and zinc, and after studying it he planned a series of tests to be made in the laboratory, which took eighteen months to complete. During all this time I had to report to him almost every day, and I had a desk in his office. Then began an intimate friendship which lasted until the day of his death. During these two years of companionship I was ever more and more impressed with Dr. Thurston's genius and with the breadth of his intellectual power. Not only was he a tireless worker, driving the pen or pounding the typewriter hour after hour, but his brain always seemed to be working as steadily and as rapidly as his pen. Whenever he was asked a difficult question the answer seemed to come instantly from his well-stored mind, and the answer was right. Such a combination of industry, rapid and clear brain-action, and broad intellectual grasp of a great variety of subjects, engineering and other, I have never known in any other man.

Such intense mental activity as Dr. Thurston exhibited in these years led to its natural result, nervous exhaustion. There was a time in 1876 when he visited the Institute only for a few minutes each day, and five minutes' conversation on any technical question would almost prostrate him. During this time he was worried by the fear that Congress would not continue the appropriation for the work of the United States Test Board, and he undertook to write a letter on the subject to one of the senators, but it took him a week or more to write the letter, working on it five minutes a day. He gave me a copy of it to take to one of the members of the board in New York City, and that member said to me that it was by far the best presentation of the subject that had ever been made. Such was the quality of his work when he was on the verge of physical collapse.

Here is another example of the kind of work he could do during the same period. He had been planning a series of tests of the triple alloys of copper, tin and zinc, and one day on one of his brief visits to the Institute he said to me: "Here is something I want to show you. Here is an equilateral triangle. It is one of the properties of this triangle that if from any point within it perpendiculars are drawn to each of the sides the sum of these perpendiculars is equal to the altitude. Now let us mark one apex 100 copper, another 100 tin, and the third 100 zinc, and the opposite sides zero copper, tin and zinc. Then any point in the triangle represents one alloy, and all the possible points represent all the possible alloys of the three metals. Now divide each altitude into ten parts, and through the points of division draw lines parallel to the three sides. The crossing points of these lines represent all the alloys whose constituents are even multiples of ten per cent. We will make these alloys and determine their tensile strength, and we will cut a lot of straight wires to lengths corresponding to the strength; then we will set these wires vertically on a board which has the triangle drawn upon it, in holes drilled at the points representing the alloys. We will then fill in this forest of wires with plaster of paris, smoothing it off so as just to leave the tops of the wires visible. We will thus have a topography which shows the general law of the relation of the tensile strength of the triple alloys to their composition." I well remember my amazement when he had completed the description, that a man with such a worn-out brain should be capable of such a brilliant piece of intellectual work and invention. The investigation of the triple alloys was carried out exactly as he had planned it, and the results were published in the Reports of the United States Test Board, and in Dr. Thurston's book on Alloys.

In 1873 Dr. Thurston discovered the phenomenon of the elevation of the elastic limit of iron and steel. It was also discovered independently in the same year by Commander L. A. Beardslee, U.S.N. In the years following he tried to find other metals or alloys that exhibited the same peculiar action after being strained beyond their elastic limit, but never found one. In 1874 he investigated the burning of tan bark for fuel in specially constructed boiler furnaces, and in 1875 and 1876 he made a number of tests of steam boilers. For some years after 1876 he carried on investigations of lubricants, the results of which are in his book on Friction and Lost Work. In later years his researches were not numerous or important, for the reason that his time was fully occupied with other work. It is a matter for lasting regret that the work of the United States Iron and Steel Test Board was discontinued almost before it was fairly started, and before the Watertown testing machine, which was built for its use, was finished.

Dr. Thurston was an omnivorous reader, and a tremendously active writer. Prior to 1880 most of his technical writings were contributed to the American Society of Civil Engineers and to the Journal of the Franklin Institute. After that date his engineering papers were mostly given to The American Society of Mechanical Engineers.

Dr. Thurston's literary work was not confined to engineering matters. In 1873 he contributed to the Scientific American a series of seventeen articles on his observations in Europe, which included not only what he had seen at the Vienna Exhibition, and in the several iron works that he visited, but also his reflections on social conditions in the manufacturing centers. Here is a quotation from his remarks on the inferiority of workmanship which then characterized many European productions:

> A liberalization of patent codes, and the gradual training of the workmen of Europe to a knowledge of the importance of good workmanship, and of the methods of securing it, will at a time which we hope is not far distant, do much toward the improvement of the condition of the people. We draw some of our best material from amongst them, and it seems sufficiently evident that not upon nature but upon man's own imperfect political systems lies the responsibility of the unsatisfactory condition of manufactures in Europe.

Dr. Thurston's first important book after his report of the Vienna Exhibition was his History of the Growth of the Steam Engine, published by Appleton in 1878. It is written in his best style, and to those who are at all interested in the subject it is as readable as a novel. It illustrates his painstaking care to be sure of his facts, his skill in arranging them in logical order, and his good judgment in drawing conclusions. In 1877 he brought out a little book on Steam Boiler Explosions in Theory and Practice.

In 1879 he had his second and last nervous breakdown, more serious than the first, so that he was compelled to spend more than a whole year in a sanitarium, doing no work of any kind. He returned to work in 1880, and then followed twelve years of most intense literary activity, during which he brought out an average of a book every year, some of them large octavos of 1000 pages. Here is a list of the books whose first editions appeared in the years 1882 to 1894 inclusive:

The Materials of Engineering. 3 vol. I, Non-metallic Materials; II, Iron and Steel; III, Brasses, Bronzes and other Alloys.
A Text Book of Materials of Construction.
Treatise on Friction and Lost Work in Machinery and Millwork.
Manual of Steam Boilers, their Design, Construction and Operation.
Handbook of Engine and Boiler Trials, the Indicator and the Prony Brake.
Translation of Sadi Carnot's "Reflections on the Motive Power of Heat and on Machines fitted to Develop that Power."
Life of Robert Fulton.
Manual of the Steam Engine. 2 vol. I, History, Structure and Theory; II, Design, Construction and Operation.
Stationary Steam Engines, Simple and Compound.
The Animal as a Machine and Prime Motor, and the Laws of Energetics.

Many of these books ran through several editions; the second volume of Materials of Engineering, Iron and Steel, is now in its ninth, and the Treatise on Friction and Lost Work, the Manual of Steam Boilers, and Stationary Steam Engines, are each in their seventh edition. The work of revising these books to keep them up to date was no small labor, and several of them have as many as four copyright dates. The Manual of the Steam Engine, and the Handbook of Engine and Boiler Trials, have been translated into French.

Most of these books are severely technical and of interest only to engineers and engineering students; but two of them, the translation of Carnot's little book and The Animal as a Machine, appeal also to those interested in advanced physics. He translated Carnot not because he thought the book would sell, but, as he says in his preface, "as a matter of limited but most intense scientific interest," and he compliments the publishers for their undertaking to print the book without any prospect of financial return. Yet in seven years a second edition was printed. Dr. Thurston's appreciation of Carnot in the introduction is a good example of his literary style when writing on non-technical subjects.

> Nicholas-Leonard-Sadi-Carnot was perhaps the greatest genius in the department of physical science that this century has produced. By this I mean that he possessed in the highest degree that combination of the imaginative faculty with intellectual acuteness, great logical power and capacity for learning, classifying and organizing in their proper relations all the facts, phenomena and laws of natural science, which distinguishes the real genius from other men

and even from simply talented men. Only now and then in the centuries does such a man come into view. Euclid was such in mathematics, Newton was such in mechanics, Bacon and Comte were such in logic and philosophy, Lavoisier and Davy were such in chemistry, and Fourier, Thomson, Maxwell, and Clausius were such in mathematical physics. Among engineers we have the examples of Watt as inventor and philosopher, and Rankine as his mathematical complement, developing the theory of that art of which Watt illustrated the practical side.

But Carnot exhibited that most marked characteristic of real genius, the power of applying such qualities as I have just enumerated to great purposes and with great result while still a youth. Genius is not dependent, as is talent, upon the ripening and the growth of years for its prescience; it is ready at the earliest maturity, and sometimes earlier, to exhibit its marvelous works; as for example note Hamilton, the mathematician, and Mill, the logician, the one becoming master of a dozen languages when hardly more than as many years of age, reading Newton's Principia at sixteen, and conceiving that wonderful system, quaternions, at eighteen; the other competent to begin the study of Greek at three, learning Latin at seven, and reading Plato before he was eight. Carnot had done his grandest work of the century in his province of thought and had passed into the Unseen at 36; his one little volume, which has made him immortal, was written when he was but 23 or 24.

A fine example of Dr. Thurston's grasp of a subject of scientific thought beyond the domain of engineering, and even beyond the present borderland of physics, is seen in the following brief extract from The Animal as a Machine:

The living body is a machine in which the law of Carnot, which asserts the necessity of waste in all thermodynamic processes and in every heat engine, and which shows that waste to be the greater as the range of temperature worked through by the machine is the more restricted, is evaded; it produces electricity without intermediate conversions and losses; it obtains heat without high temperature combustion; and in some cases light without any sensible heat. In other words, in the vital system of man and of the lower animals, nature shows us the practicability of converting any one form of energy into any other, without those losses and unavoidable wastes characteristic of the methods, the invention of which has been the pride and the boast of man. Every living creature, man and worm alike, shows him that his task is but half accomplished; that his grandest inventions are but crude and remote imitations; that his best work is wasteful and awkward. Every animate creature is a machine of enormously higher efficiency as a dynamic engine than his most elaborate constructions. Every gymnotus living in the mud in a tropical stream puts to shame man's best effort in the production of electricity; and the minute insect that flashes across his lawn on a summer evening, or the worm that lights his path in the garden, exhibits a system of illumination incomparably superior to his most perfect electric lights . . . Here is Nature's challenge to man. Man wastes one-fourth of all his fuel as utilized in his steam boiler, and often 90 per cent as used in his fireplace; nature in the animal system utilizes substantially all.

Dr. Thurston was an occasional contributor to such journals as the Popular Science Monthly, the Forum, Science, and the North American Review. Sometimes he went outside of the field of the physical sciences and wrote on sociological and economic subjects, such as the tariff. Once he wrote for the North American Review a statement of his religious convictions.

He frequently wrote papers and delivered addresses on educational subjects, and in these he was naturally at his best. For nearly forty years he was an educator and an educational leader. He was versed in the theories of Froebel, Milton and Comenius; and of Spencer, John Scott Russell and other modern writers. His paper on Technical Education in the United States; its Social, Industrial and Economic Relations to our Progress, read at the International Engineering Congress at Chicago in 1893, is one of his masterpieces. It is a calm, scholarlike review of the conditions of the past, and a hopeful view of the future. He propounded no new theories, he originated no new fads, but he was in line with the best thinkers of his time, and thoroughly in sympathy with the modern trend toward industrial or trade education for the great mass of the people.

DR. THURSTON AT SIBLEY COLLEGE, CORNELL UNIVERSITY

By Walter C. Kerr

Member of the Society; Trustee of Cornell University

What a man is, makes less difference to the world than what his life teaches; the man departs, but his teaching remains. It would be impossible for me to relate here the full importance of the eighteen years that Dr. Thurston devoted to Cornell University. Prior to 1885 Cornell was developing a department of mechanic arts in a small way, recognizing the necessity and opportunities of mechanical engineering. With a profitable sale of the university's timber lands the trustees felt warranted in taking forward steps, chief among which was the founding of a new department, and to this department of mechanical engineering Dr. Thurston was called as the first director. No choice was ever more fortunate. I will not undertake to recount all that followed in physical development from his administration, except to say that the number of students increased from one hundred to eleven hundred, buildings grew, facilities grew, everything that his hand touched grew, and all the growth was healthy. Professor

Thurston was especially an organizer, and of the very best kind. This was because he knew what to organize. His methods were direct and practical, he knew men, he understood human nature; and all resistance was to him merely a retardation, not a stopping, and consequently he gained whatever he set out to do.

By temperament, education and experience he was peculiarly fitted to direct socially and intellectually an important department in a complex institution; by his touch with all the forces of life he was an important factor in any community in which he lived, and this gave him a profound and wide influence for good through a much larger circle than that of engineering. He convinced men, by persuading them to want what he wanted, and the result was that he usually gained his end with the minimum of argument. His ever-present cheerfulness was an inspiration, and his patience was an example. There is no subtle mystery about why he was so loved and respected at Cornell, nor why he accomplished so much. His ways were ways of peace, and his achievements were a series of creative victories. He was a strong man, so strong that we honor his memory tonight. He has gone, but the influence of his life lives.